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ABL -- AUTOMATED BIOLOGICAL LABORATORY

Approaches to the biological exploration of Mars: Collections of experiments versus a general purpose laboratory

1. THE VOYAGER MODEL. In 1971 (perhaps 1973 or both) a scientific payload of from 10 to 100 pounds will be landed on Mars. To meet this opportunity, NASA is advertising for commitments from scientists starting 1965. Each respondent must not only defend the scientific value of his experiment; he must also justify his ability and sustain an obligation to oversee the engineering development of one device that will execute a particular analysis. After a point some two to four years before landing, no significant alterations will be tolerable, and there will certainly be almost no chance to take advantage of any further scientific developments, whether from terrestrial biological research, astronomy, or other reconnaissance missions to Mars. There will be still less chance to take further steps depending on the outcome of the first measurements of the same landing mission.

This opportunity can be accepted as a realistic challenge only by the most engineering-minded biologists, and these in general do not represent the most capable experimental or theoretical talents in biology. Furthermore, the usual process of continued scientific criticism can hardly apply when unique choices must be made for the implementation of each experimental approach. The net result must be a rather narrow, possibly unfruitful mission, in which a minimum of general scientific interest has been involved. This also entails very narrow understanding of the mission and its experiments by the scientific community, which is bound to have a deleterious impact on public support and understanding. Important supporting policies, in connection with decontamination for example, will also suffer from this imperfect involvement.

2. THE ABL MODEL. By 1975 (perhaps sooner) the possible payload of a Mars lander will reach 1000 to 10,000 pounds. A payload of this size would support an automated general-purpose laboratory. Except that it will function from the Martian surface, its nearest precedent may be found in the orbiting astronomical observatories. The principal functions of the ABL would be biological research (as this is understood to be the most cogent challenge of missions to Mars). However, the name may be misleading since the ABL would also be the platform for many other forms of Mars research, few of which are actually unrelated to biology if they tell us more about the local environment. The ABL would include a storeroom of reagents and the analytical instrumentation to make it possible to program a wide variety of experiments analogous to those of terrestrial science. (Spectrophotometry, chromatography and mass-spectrometry may be expected to dominate the chemical analytical systems; this should not preclude a panoply of visual, radiometric and other physical measurements).

Most participating scientists would be in competition, not for payload weight or engineering support, but for prorated time on the system. Computer logic would direct the execution of the main subroutines of, say, sampling and biochemical analysis, but would be supervised and reprogrammable by command from earth to allow full advantage to be taken of stepwise or scientifically competitive programs. The participants could have overlapping interests, and could be chosen on the basis of their special scientific rather than engineering or managerial talents. Many of them could become involved quite late in the development of the program -- in some cases even after the system had begun to report its first results. There could then be the widest participation of the scientific community at least in the choice of priorities for experiments, and to a very large extent in their execution.

To implement such a program, NASA must take urgent steps for the development and demonstration of prototypes of this approach to experimental science. However, this has enormous by-product value for terrestrial science. Furthermore, the architects of such a program can be chosen for their zeal and abilities to develop this phase without impairing a much wider base for the use of the laboratory. An example of a prototype would be the assimilation to computer control of some existing, productive research laboratory, starting with a single department. The scope of the entire laboratory would be more nearly comparable to a fair sized research institute or medical school. Such a system seems to be technologically feasible, and could greatly enhance the productivity of existing institutions. However, despite the accomplishments of process control in chemical industry, and of data processing in high energy physics and in space technology, thereis so far no precedent for advanced, penetrating computer-controlled automation in biochemical research and many problems must be identified and solved on the ground. One of the most urgent of these is scheduling and time-sharing to allow the harmonious control of the traffic of information and commands.

A vital extrapolation of the ABL would allow each participant to remain in his own institution, in touch with his other affairs and responsibilities, and keeping access to his own laboratory for continued backup research, during the months or years of continued operation of the ABL. He would then require a peripheral console of communication to the command-and-control central. The implementation of such a network has obvious implications for upgrading the technological capability of the whole national effort in science. It has the very appropriate corollary of making it possible for every scientist to contribute to the exploration of the rest of the universe.

3. RECONNAISSANCE FOR AN INTERIM POLICY. The ABL approach indicates how feeble the Voyager efforts will be by comparison. Rather than accept the accompanying hazards, and especially those of contamination, the next missions should concentrate on the observation of Mars from a distance. If possible, they could emulate the same approach of a general purpose observatory; the choice of target areas for measurement, of data acquisition modes, and of data selection for telemetry might be under more detailed but reprogrammable control than has usually been discussed. While landers are essential for the final resolution of important scientific questions about Mars, there are many aspects of the planet that need much more information of the kind that could be obtained from a distance -- to give one example, whether there are rare oases harboring warmer and moister habitats than are probably typical of the surface generally. As stressed before, the chance that a decontamination policy will be really stringently <u>implemented</u> in the face of probable difficulties will be greatly weakened before there is very general scientific involvement in the program.

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